Segmented MEMS Mirror Arrays, Phase I

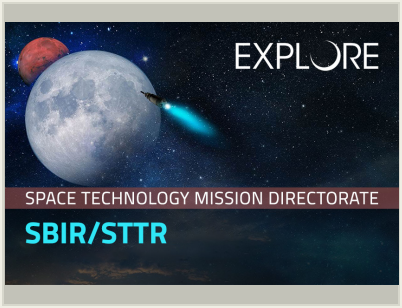
Completed Technology Project (2004 - 2004)

Project Introduction

The objective of this proposal is to demonstrate the feasibility of manufacturing large-throw, low cross-talk, high resolution and fast responding-speed wavefront control devices based on micro-electro-mechanical (MEMS) fabrication process. The device consists of Segmented Membrane Arrays (SMA) and bottom electrodes with Backside Solder Bump (BSB). The design is going to use arrays of mirror pixels to eliminate the cross talk with adjacent elements, which is usually observed in continuous membrane devices. Each mirror pixel could perform both piston motion and tip-tilt motion to eliminate diffraction noise from the mirror edges. Since each mirror pixel is independent from each other, the resonant frequency of the arrays will not decrease as the array aperture scales up. The BSB provides the packaging solution for high-resolution devices by direct electric contact through solder bump, instead of conventional wire bond techniques. It opens new opportunities to make ideal deformable mirrors with large-throw and independent addressing capabilities.

Anticipated Benefits

Potential NASA Commercial Applications: Due to the nature of batch fabrication process of SMA, the cost could drop dramatically. The typical cost to manufacture a 6 inch wafer using a mature CMOS (pure electronic) process is approximately $10K per wafer. Additional processes to bond the BSB and electronic circuits will add an additional $10K. After factoring in other possible costs, as well as a 100% makeup in the price, each wafer should cost no more than $50K. Now, we know that the total resolution of this 6inch wafer will be 1000X1000, i.e. one million elements. Therefore, the cost per element is $0.05. We compare with currently available 6 inch diameter deformable mirrors with actuators in the order of 10X10 elements, the total cost per device will be $100K because each actuator cost $1K typically to perform both tip-tilt and piston motion. Considering the price per actuators drop from $1K to $0.05 (5 orders of magnitude) due to MEMS batch fabrication process, it seems reasonable that the development of MEMS will open up more potential applications in both commercial and military fields which were previously impossible to consider due to the high-cost of deformable mirrors.



Segmented MEMS Mirror Arrays, Phase I

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

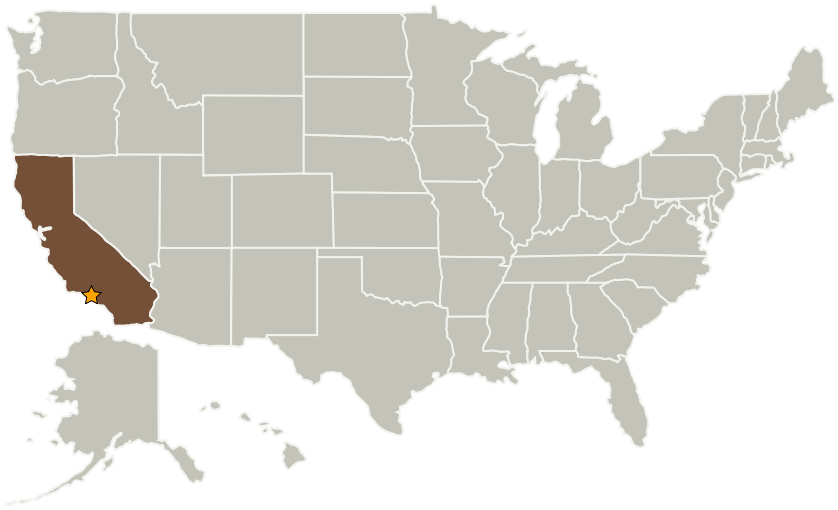
Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Segmented MEMS Mirror Arrays, Phase I

Completed Technology Project (2004 - 2004)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Umachines, Inc.	Supporting Organization	Industry	Altadena, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Tom Tsao

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems